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Calosoma aethiops (Jeannel, 1940) as a new synonym of *Calosoma imbricatum hottentotum* Chaudoir, 1852, a new status of *Calosoma roeschkei* Breuning, 1927, and a revision of the *Calosoma senegalense* group sensu Häckel, 2012 (Coleoptera, Carabidae, Carabini)

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Abstract

Calosoma aethiops (Jeannel, 1940) as a new synonym of *Calosoma imbricatum hottentotum* Chaudoir, 1852, a new status of *Calosoma roeschkei* Breuning, 1927, and a revision of the *Calosoma senegalense* group sensu Häckel, 2012 (Coleoptera: Carabidae: Carabini). Conducted is a taxonomic revision of the *Calosoma senegalense* group sensu Häckel, 2012. Placed in the group sensu stricto are four species: *C. planicolle* Chaudoir, 1869, *C. scabrosum* Chaudoir, 1843, *C. senegalense* Dejean, 1831, and *C. strandi* Breuning, 1934. *Calosoma aethiops* Jeannel, 1940 is synonymized with *C. imbricatum hottentotum* Chaudoir, 1852, and *C. roeschkei* Breuning, 1927 is newly regarded as a subspecies of *C. scabrosum*. The taxonomic conclusions are based on morphometry of the holotypes and 10 male and 10 female specimens of each taxon, and on morphology of the aedeagus including inflated endophalus.

Keywords

Carabidae, Carabinae, *Calosoma*, new synonymy, Africa

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Introduction

Calosoma is the second most speciose genus of the subfamily Carabinae, with 168 (Lorenz 2005), 128 (Bruschi 2013) or 129 (Häckel 2013) species described from all zoogeographic regions. Most species are excellent fliers widely distributed on all continents and numerous islands, but some are secondarily brachypterous or apterous with narrow distributions (Bruschi 2013, Häckel 2012). Some species inhabit more zoogeographic regions, and some extend to a neighboring continent that belongs in the same zoogeographic region (Häckel 2012). Examples of such distributions are some species of the *C. maderae* group (*C. imbricatum* subgroup sensu Häckel 2013) and of the *C. senegalense* group (*C. senegalense* subgroup sensu Häckel 2013), which inhabit the area of the Horn of Africa. The distributions are probably to some extent responsible for the unsettled situation in the species-level taxonomy of the group (Bruschi 2013, Häckel 2012, 2013, Häckel & Farkač 2012), a part of which this paper attempts to resolve. At the same time it respects the recent supraspecific classification (Häckel 2013), which in light of the known genetic analyses (Su et al. 2005) does not support the traditional subgeneric divisions.

Material and methods

The classification of the group is based primarily on external structural details of the adult, with species-level taxonomy relying also on structural details of the expanded endophalus. The aedeagi were dissected, preserved, studied dry and glued on cards appended beneath the dissected specimens. For study of the endophalus, the aedeagus was soaked 48 hours in 1:1 solution of water and 8% acetic acid, and then the endophalus was inflated using a small Heavy Duty (12V) compressor normally used to inflate tires, set at medium pressure. Fixation of the endophalus morphology was secured by slow drying on a portable electric (220V) single-plate heater, and the whole aedeagus-endophalus preparation was then glued on a paper card. The preparations were photographed by Canon G10 Digital Compact in macrophoto regime with flash. Aedeagi were photographed in the right lateral view, with details of their tips also slanted at an angle.

Inspected and evaluated were the following morphometric parameters of the holotypes and 20 samples (10 males and 10 females) of each species:

a) total length of the adult including mandibles (TL),
b) maximum head width including eyes to maximum pronotal width ratio (WP/WH),
c) maximum pronotal length to maximum width ratio (WP/LP),
d) maximum elytral length to maximum width ratio (LE/WE).

Subjective evaluations included also differences in termination of the aedeagus (apex) and of the inflated endophalus. Measured were morphometric parameters of 10 males and 10 females of the following taxa: *C. planicolle*, *C. scabrosum scabrosum*, *C. scabrosum roeschkei*, *C. senegalense*, *C. strandi* (all taxa belong to *C. senegalense* group),

and *C. imbricatum imbricatum* from populations inhabiting the Afrotropical region (including Oman and Yemen on the Arab peninsula) and *C. imbricatum hottentotum* (*C. maderae* group, *C. imbricatum* subgroup). Measured holotypes include *C. scabrosum* (Chaudoir), *C. scabrosum roeschkei* (Breuning), *C. imbricatum hottentotum* (Chaudoir) and *C. aethiops* (Jeannel).

The material examined is housed in the collections listed below:

cMNHN Muséum national d'Histoire naturelle, Paris, France
cNBCL National Biodiversity Center, Leiden, Netherlands
cNMP Národní muzeum, Prague, Czech Republic
cFAR Jan Farkač collection, Prague, Czech Republic
cHAC Martin Häckel collection, Hostivice, Czech Republic
cSEH Rostislav Sehnal collection, Unhošť, Czech Republic
cWRA David W. Wrase collection, Berlin, Germany

Systematic part

C. senegalense species group (sensu Häckel 2013):

C. senegalense subgroup (= *C. senegalense* group s. str.)

***Calosoma* (*Calosoma*) *planicolle* Chaudoir, 1869**
Plate 4: Fig. 4

Calosoma planicolle Chaudoir, 1869: 369 (type loc. "près du Zambéze", type in cMNHN).
Calosoma procerum Harold, 1880: 260 (type loc. "Taita District, Kenya Colony, Ukamba"), syn. sn. Breuning 1927: 188.
C. (*Ctenosta*) *planicolle* Breuning, 1927: 188. Lapouge 1932: 415; Deuve 1978: 250; Culot 1990: 9; Lorenz 2005: 68; Bruschi 2013: 132.
Ctenosta (s. str.) *planicolle* Jeannel, 1940: 130. Rougemont 1976: 248; Vigna Taglianti and Bruschi 1986: 22.
Calosoma (s. str.) *planicolle* Häckel, 2013: 30.

Material studied. BOTSWANA. 1♂, 3♀: Ngamiland district, ne. of Maun, Tamalakane (cHAC).

KENYA. 1♂, 1♀: Tsavo, Mtitoanday (cSEH); 1♂, 1♀: Eastern 729, Sosoma, 202 km E of Thika (cSEH).

MOZAMBIQUE. 1♀: Sofala province, 30 km S Caia (cSEH).

Namibia. 1♂: Kavango reg., Okavango river, Rundu, 1050 m (cHAC); 1♂, 1♀: Caprivi reg., Bagani- Popa Falls (cHAC).

Zambia. 1♂: Southern Prov., Livingstone env., Victoria Falls (cHAC).

Zimbabwe. 1♂, 2♀: Midlands Prov., Kwekwe env. 20 km w. Ngezi Park (cHAC); 1♂, 1♀: Matabeleland Prov., 60 km N of Bulawayo, Marapoosa road (cHAC); 2♂: Masvingo province, 95 km NE Beitbridge, Bubi river (cSEH)

Distribution. Angola, Botswana, Democratic Congo, Ethiopia, Kenya, Lesotho, Madagascar, Malawi, Mozambique, Republic of South Africa, Somalia, Tanzania, Swaziland, Uganda, Zambia, Zimbabwe.

Calosoma (*Calosoma*) *scabrosum scabrosum* Chaudoir, 1869

Plate 1: Fig. 1. Plate 2: Figs 1–2. Plate 4. Fig. 1.

Calosoma scabrosum Chaudoir, 1843: 745 (type loc. "Kordofan").
Calosoma kordofanum [Kollar in litt.] syn. sn. Chaudoir 1852: 100.
Calosoma (*Ctenosta*) *scabrosum* Breuning, 1927: 185. Lapouge 1932: 414; Deuve 1978: 250; Culot 1990: 9; Lorenz 2005: 68; Bruschi 2013: 127.
Ctenosta (s. str.) *scabrosum* Jeannel, 1940: 128. Rougemont 1976: 247; Vigna Taglianti and Bruschi 1986: 21.
Calosoma (*Ctenosta*) *jakli* Häckel, Farkač & Sehnal, 2005: 2 (type loc. "Oman: Dhofar"), syn. sn. Häckel et al., 2010: 11.
Calosoma (s. str.) *scabrosum* Häckel, 2012: 57. Häckel 2013: 31.

Type material. ***Calosoma scabrosum*** **Chaudoir, 1869.** 1♂ labelled "HOLOTYPE / Ex Musaeo Chaudoir / Ctenosta scabrosum (Chd.) P. Basilewsky vid. 1992 (cMNHN); 1♂ labelled "SW Asia, S Oman, Dzhopar Prov., Al Mughsayi vill. env., 0–50 m a.s.l., VIII.1999, lgt. S. Jákl / HOLOTYPE Calosoma jakli det. Häckel, Farkač & Sehnal, 2005 / Calsoma scabrosum det. Häckel, Farkač & Sehnal, 2010" (cHAC).

Other material studied. Djibouti. 1♂: "Obock" (cNMP).

Oman. 5♀: Dzhophar Prov., Takwa env., 50 m a.s.l. (cFAR, cHAC, cSEH); 1♀: rd. Al Mughsayi – Salalah, ca 3 km from Mughsayi, 20 m a.s.l. (cFAR); 1♀: Dhophar Province, Takwa env., 200 m a.s.l. (cKAL); 3♂, 2♀: Dzhofar prov., Wadi Nashib, 24 km E Salalah (cHAC, cSEH); 5♂: Dzhofar prov., Wadi Nashib, 20 km E Salalah (cHAC, cSEH).

SENEGAL (Niger or Chad probably). 1♀: "Senegal" (cNMP).

Yemen. 1♂: NW Al Mukhallā: N: 14°37';/ E: 49°03' Kawr Saybān Mtn. (cHÄC).

Distribution. Chad, Djibouti, Eritrea, Ethiopia, Kenya, Niger, Nigeria, Oman, Somalia, South Sudan, Tanzania, Yemen. Data from Burundi, Rwanda and Uganda need confirmation.

Calosoma (*Calosoma*) *scabrosum roeschkei* Breuning, 1927

Plate 1: Fig. 2. Plate 2: Fig. 3. Plate 3: Fig. 3. Plate 4: Fig. 2.

Calosoma (*Ctenosta*) *scabrosum roeschkei* Breuning, 1927: 185 (type loc. "Usambara").
Ctenosta (s. str.) *aethiops* (partim) Jeannel, 1940: 128 (loc. "Diré-Daoua"); Rougemont 1976: 247. Vigna Taglianti and Bruschi 1986: 21.

Ctenosta (s. str.) *orientale* (partim) Jeannel, 1940: 129 (loc. "Érythrée: Tessenei").
Ctenosta (s. str.) *scabrosum* var. *roeschkei* Jeannel, 1940: 128.
Calosoma (*Ctenosta*) *aethiops* Culot, 1990: 9. Lorenz 2005: 68.
Calosoma (s. str.) *scabrosum* Häckel, 2012: 57. Häckel 2013: 31.
Calosoma (*Ctenosta*) *roeschkei* Bruschi, 2013: 129.

Type material. *Calosoma roeschkei* Breuning, 1927. 1♂ labelled "Usambara"(cNBCL).

Other material studied. Kenya. 1♂, 1♀: E of Garsen, W of Witu (cSEH); 2♂, 1♀: S of Voi (cHAC); 1♂, 1♀: Taita prov. Sagala Hills, Voi env. (cHAC); 1♂: Tsavo East, Voi Lodge, 3.23S/38.34E (cWRA); 1♀: NE prov. El Wak (cHAC); 1♂, 1♀: Modo Gashi to Wajir (cHAC); 2♂, 2♀: Coast province, Garissa, N of Bura (cHAC, cSEH), 1♂: Amboseli National Park (cSEH); 2♀: Eastern 729, Sosoma, 202 km E of Thika (cSEH).

Sudan. 1♂, 1♀: Vad Medani (cSEH).

Geographic distribution. Chad, Kenya, Somalia, Sudan, Tanzania.

Calosoma (*Calosoma*) *senegalense* Dejean, 1831

Plate 4: Fig. 5

Calosoma sengalense Dejean, 1831: 562 (type loc. "Sénegal").
Calosoma mossambicense Klug, 1853: 247 (type loc. "Téte"). *C.* (*Ctenosta*) *senegalense mossambicense* Breuning, 1927: 187.
Ctenosta senegalense Motschulsky, 1865: 306.
Calosoma (*Ctenosta*) *senegalense* Breuning, 1927: 187. Lapouge 1932: 415. Deuve 1978: 247; Culot 1990: 9; Lorenz 2005: 68; Bruschi 2013. 131.
Ctenosta (s. str.) *senegalense* Jeannel, 1940: 129. Rougemont 1976: 248; Vigna Taglianti and Bruschi 1986: 21.
Calosoma (s. str.) *senegalense* Häckel, 2012: 58, 64; 2013: 31.

Material studied. Botswana. 1♂, 1♀: Ngamiland district, ne. of Maun, Tamalakane (cHAC).

Ethiopia. 1♂, 1♀: Gambela region, Gambela env., 400 m (cHAC).

Ghana. 1♂, 1♀: Northern Prov., West Gonja district, Damongo env. (cHAC).

Kenya. 1♂, 1♀: Coast Prov., Taita-Taveta Co., s. of Voi (cHAC).

Madagascar. 1♂, 2♀: Toliara prov., Ampanihy district, Ejeda env. (c FAR, cHAC); 1♂, 1♀: Mahajanga Prov., Ampatika env., Mahajamba river (cHAC).

Namibia. 1♂: Caprivi reg., Bagani- Popa Falls; 1♀: Khomas region, 40 km e. Windhoek (airport) (cHAC).

Senegal. 1♂, 1♀: Thiès region, M'bour department, Saly Portudal (cHAC).

Tanzania. 1♂: Arusha reg., Mto Wa Mbu env. (cHAC); 1♀: Morogoro region, Mikumi (cHAC). **Zimbabwe.** 1♂: 20 km NE Shamva, Nyagui river (cHAC).

Distribution. Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cabo Verde Islands, Chad, Congo, Côte d'Ivoire, Democratic Congo, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Guinea Equatorial, Kenya, Lesotho, Li-

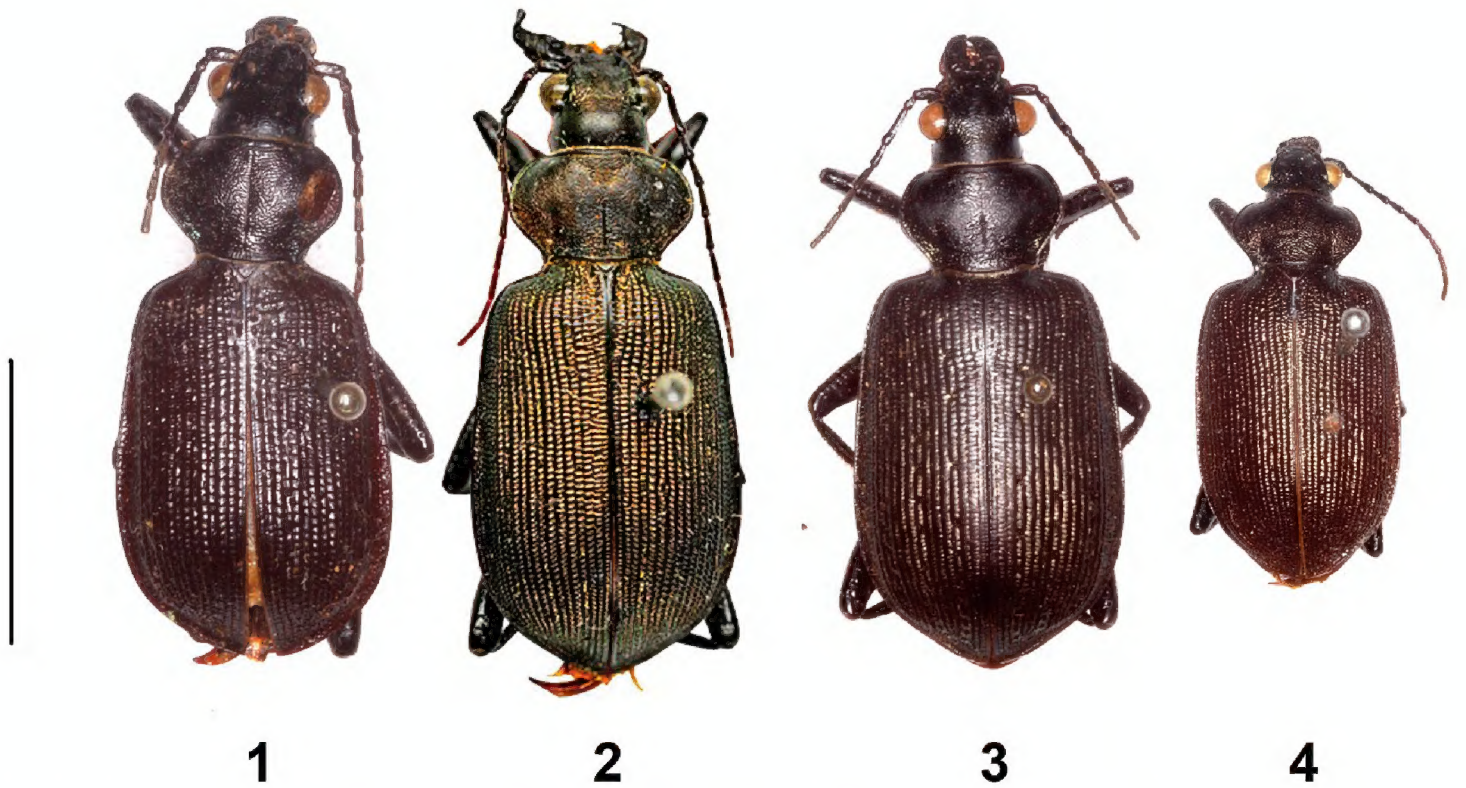


Plate 1. Type material (habitus in dorsal aspect, male). Scale bar equals 10 mm. **1** *C. scabrosum scabrosum* (holotype) **2** *C. scabrosum roeschkei* (holotype) **3** *C. imbricatum hottentottum* (holotype of *Ctenosta aethiops* Jeannel, 1940) **4** *C. imbricatum hottentottum* (holotype).

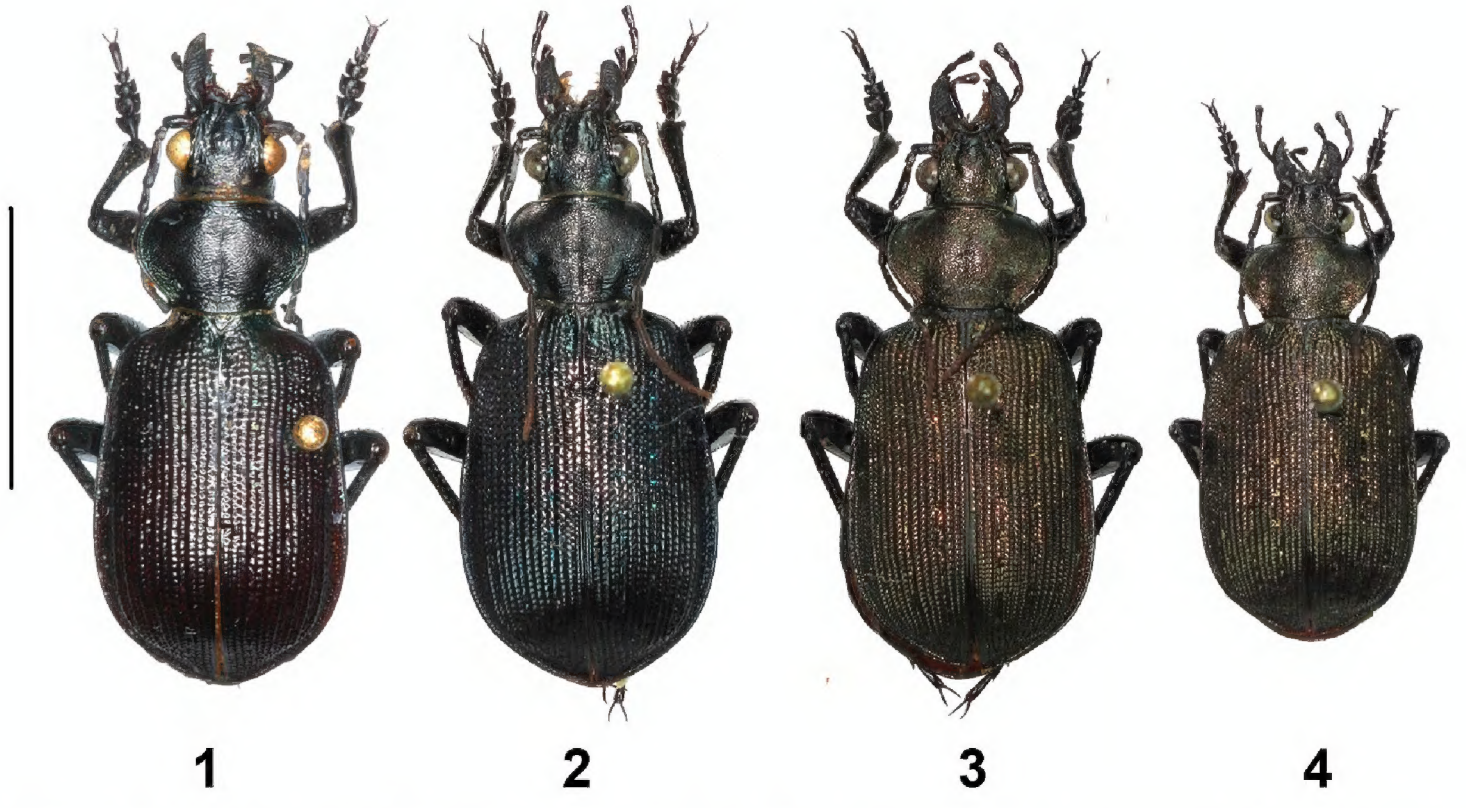


Plate 2. Material studied (habitus in dorsal aspect, male). **1** *C. scabrosum scabrosum* (Djibouti: Obock) **2** *C. scabrosum scabrosum* (Oman: Dhofar, holotype of *C. jakli* Häckel, Farkač & Sehnal, 2005) **3** *C. scabrosum roeschkei* (Kenya: Voi env.) **4** *C. imbricatum hottentottum* (Namibia: Okahandja). Scale bar equals 10 mm.

beria, Madagascar, Malawi, Mali, Mauritania, Mozambique, Namibia, Niger, Nigeria, Republic of Central Africa, Republic of South Africa, Rwanda, Senegal, Sierra Leone, Somalia, Swaziland, Tanzania, Togo, Uganda, Zambia, Zimbabwe.

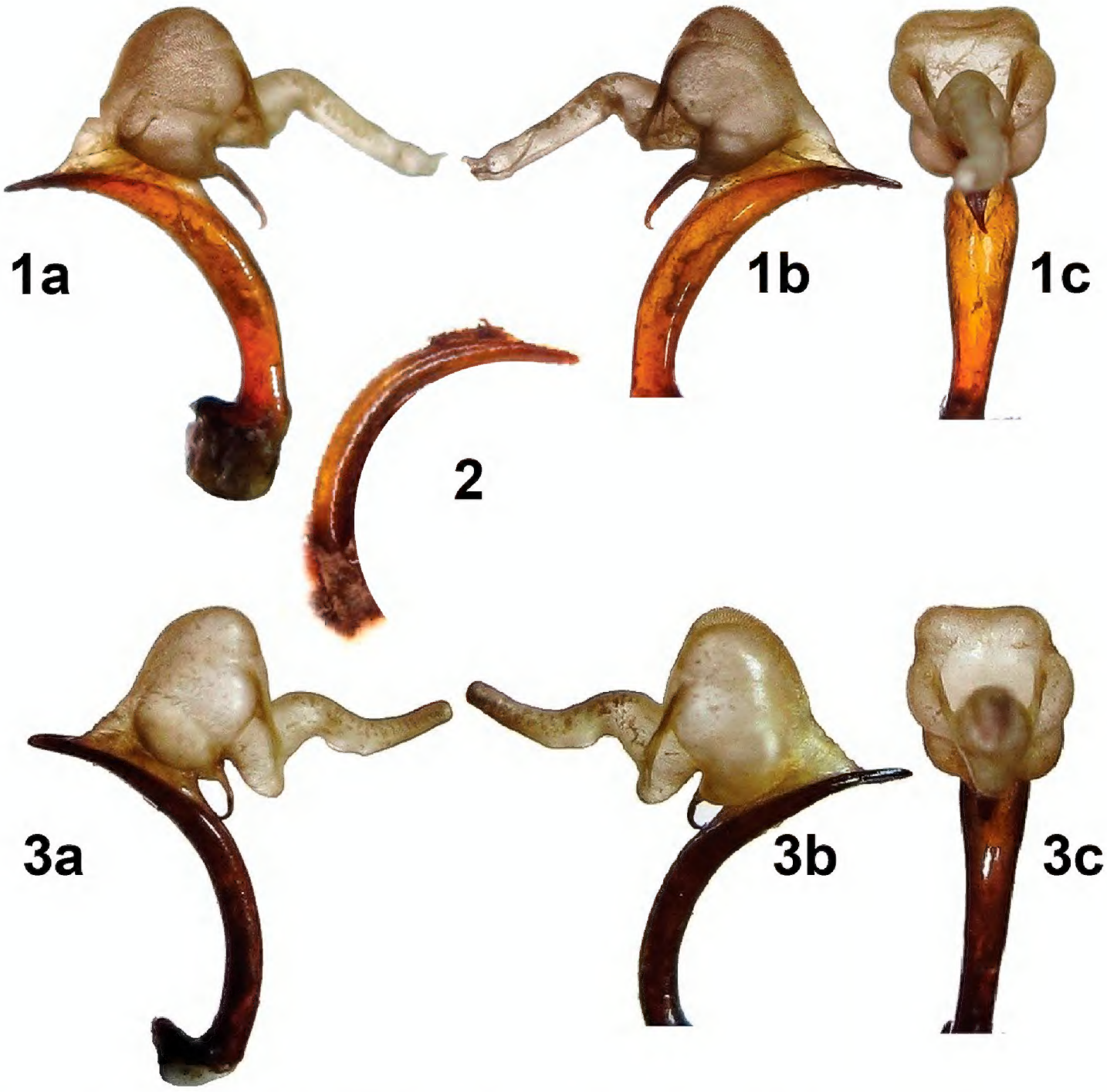


Plate 3. Aedeagi of *C. imbricatum hottentotum* (Namibia) and *C. scabrosum roeschkei* (Kenya) compared with aedeagus of "*C. aethiops*" (holotype). **1** *C. imbricatum hottentottum* (Namibia: Okahandja); a – aedeagus with expanded endophalus in right lateral view, b – the same in left lateral view, c – the same in anterior view **2** *C. imbricatum hottentottum* (holotype of *Ctenosta aethiops* Jeannel, 1940) aedeagus in left lateral view **3** *C. scabrosum roeschkei* (Kenya: Voi env.), a – aedeagus with expanded endophalus in right lateral view, b – the same in left lateral view, c – the same in anterior view.

Calosoma (*Calosoma*) *strandi* Breuning, 1934

Plate 4: Fig. 3.

Calosoma (*Ctenosta*) *strandi* Breuning, 1934: 38 (type loc. "Masaua"). Culot 1990: 9; Lorenz 2005: 68; Bruschi 2013: 130.

Ctenosta (s. str.) *strandi* Jeannel, 1940: 130. Rougemont 1976: 244; Vigna Taglianti and Bruschi 1986: 21.

Calosoma (s. str.) *strandi* Häckel, 2013: 31.

Material studied. Kenya. 8♂, 6♀: North-Eastern Prov., El Wak. (cFAR, cHAC, cSEH); 2♂, 4♀: Eastern Prov. Marsabit to South Horq (cFAR, cHAC, cSEH).

Distribution. Eritrea, Ethiopia, Kenya, Somalia.

C. maderae species group (sensu Häckel 2013)

C. imbricatum subgroup

Calosoma (*Calosoma*) *imbricatum imbricatum* Klug, 1832

Calosoma imbricatum Klug, 1832: pl. IX. (type loc. "Cap Vert"). *Calosoma* (*Caminara*) *imbricatum* Breuning, 1927: 221. *Caminara* (*Caminara*) *imbricata* Lapouge 1932: 410, Jeannel 1940: 104. Culot 1990: 7; Lorenz 2005: 69; Bruschi 2013: 76, Häckel 2013: 24.

Caminara arabica Motschulsky, 1865: 304. *Caminara imbricata arabica* Lapouge 1932: 410.

Calosoma (*Caminara*) *loffleri* Mandl, 1953: 57.

Calosoma (*Caminara*) *loffleri* m. *rufoapendiculata* Mandl, 1967: 44.

Calosoma (Caminara) linnavouri Mandl, 1970: 61.

Material studied. Kenya. 1♂, 1♀: Marsabith to South Orr (cHAC).

Oman. 8♂, 8♀: Wadi Qitbit, 150m (cFAR, cHAC, cSEH).

Senegal. 1♀: Senegal (cHAC).

Sudan. 1♂: Port Sudan (cHAC).

Distribution. Algeria, Cabo Verde Islands, Canarian Islands, Chad, Djibuti, Egypt, Eritrea, Ethiopia, western India, Iran, Iraq, northern Kenya, Kuwait, Libya, Mali, Niger, Oman, Pakistan, Saudi Arabia, Senegal, Somalia, Sudan, United Arab Emirates, Yemen.

Calosoma (*Calosoma*) *imbricatum hottentotum* Chaudoir, 1852

Plate 1: Figs 3–4. Plate 2: Fig. 4. Plate 3: Figs 1–2. Plate 4. Fig. 6.

Calosoma hottentotum Chaudoir, 1852: 99 (type loc. "Cap de bonne-Espérance"). Deuve 1978: 249.

Calosoma (*Caminara*) *imbricatum hottentotum* Breuning, 1927: 221. Mandl 1970: 61, 62; Culot 1990: 7; Lorenz 2005: 69; Bruschi 2013: 76.

Caminara (*Caminara*) *imbricata hottentota* Lapouge, 1932: 410. Jeannel 1940: 105.

Ctenosta (s. str.) *aethiops* Jeannel, 1940: 127 (type loc. "Azbin, à 20 km. d'Agadès, dans l'Aïr"), **new synonym.**

Calosoma (s. str.) *imbricatum hottentotum* Häckel, 2013: 24.

Type material. 1♂ labelled "LECTOTYPE / Ex Musaeo Chaudoir / Calosoma hottentotum Lectotype Chaud. 1852 Th. Deuve det,. 1978" (cMNHN); 1♂ labelled

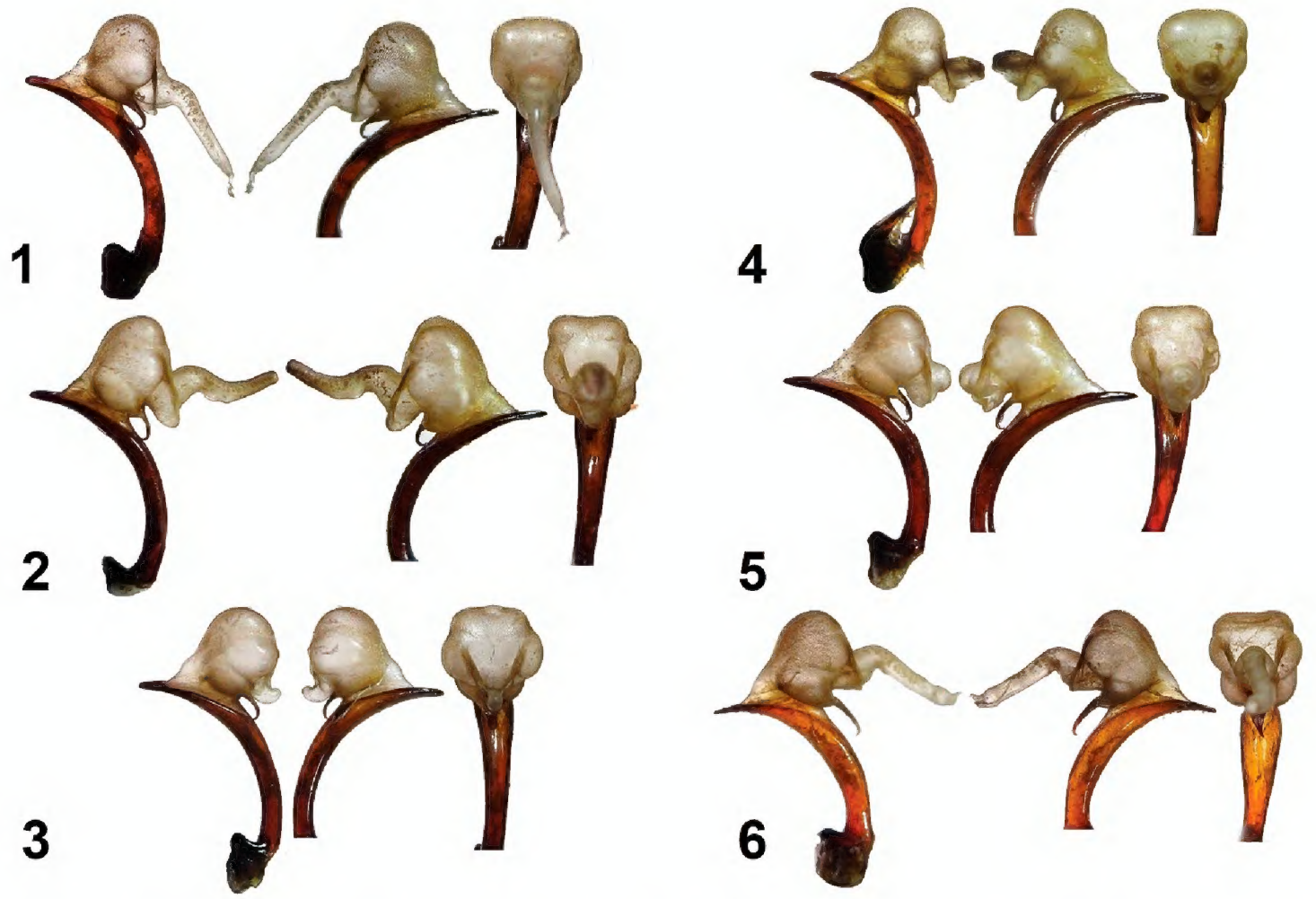


Plate 4. Aedeagi of *C. senegalense* species group (sensu Häckel 2012: 30) and *C. imbricatum hottentotum* (Namibia). a – aedeagus with expanded endophalus in right lateral view, b – same in left lateral view, c – same in anterior view **1** *C. scabrosum scabrosum* (Oman: Dhofar) **2** *C. scabrosum roeschkei* (southeastern Kenya: Voi env.) **3** *C. strandi* (northeastern Kenya: El Wak) **4** *C. planicolle* (Namibia: Kavango) **5** *C. senegalense* (Zimbabwe: Shamva) **6** *C. imbricatum hottentottum* (Namibia: Okahandja).

"MUSEUM PARIS AZBIN (AIR) REG. de TINTABORAC 20 K E d' AGADÈS CAPde POSTH 1908 / HOLOTYPE / aethiops n. sp. Jeannel det." (cMNHN).

Other material studied. Kenya. 1♂, 1♀: Amboseli National Park (cSEH).

Namibia. 2♂, 2♀: Omaruru (cHAC); 5♂, 3♀: Okahandja, Gross Bamen (cHAC, cSEH); 1♀: Otjivarongo (cSEH); Gobabis-Aranos (cSEH); 1♂: Maltahohe (cSEH).

Republic of South Africa. 1♂, 3♀: Northern Cape Province, SW Kimberley, 13 km SW Ritchie (cHAC).

Distribution. Southern Kenya, Namibia, Tanzania, Republic of South Africa.

Comments on classification

Our study shows the following:

1. Termination (apex) of the aedeagus. We have found no difference in shape of the apex among species or subspecies within the same group, the shape is distinct only among species belonging to different groups. The apex of *C. imbricatum* (narrower

and sharper, Plate 3: Figs 1–2. Plate 4: Fig. 6) differs from those in all species of the *C. senegalense* group (more blunt apex, Plate 3: Fig. 3. Plate 4: Figs 1–5). The apex in Jeannel's holotype of *C. aethiops* corresponds to that in the *C. imbricatum* group (Plate 3), which does not support the opinion of Bruschi (2013) that *C. aethiops* is a synonym of *C. scabrosum roeschkei*.

2. Shape of inflated endophalus. We have not found an apparent difference either among species or subspecies belonging to the same group, or among species belonging to different groups (Plate 4: Figs 1–5). This result does not support the opinion that shape of the endophalus can be used to indicate assignments to to species or species groups.
3. Morphometric parameters.
   A. Total length including mandibles (TL). In three measured holotypes (or lectotypes) are the values within the minimum and maximum intervals found in corresponding populations and sexes, whereas in the male holotype of *C. aethiops* the value is outside of the interval. The TL value in the *C. aethiops* holotype is closest to the values found in males of *C. i. hottentotum*, and lies within the interval found in females of that subspecies (all types are males, see Table 1a, Table 2). This fact supports our opinion that the holotype of *C. aethiops* is an extremely large male of *C. i. hottentotum*.
   B. Maximum pronotal width to maximum head width including eyes ratio (WP/WH). The WP/WH in two measured holotypes (or lectotypes) is within the minimum and maximum intervals found in the pertinent populations and sexes. In the third taxon the WP/WH value of the holotype is outside of the interval in both sexes. In the holotype of *C. aethiops* is the WP/WH value within the interval found in the corresponding sex (males) of *C. s. roeschkei* and also within the interval found in *C. i. hottentotum* females. Overall the WP/WH values found in the measured taxa is very variable in both species and sexes (Table 1b, Table 2), and in our opinion thus cannot be used as a criterion in species-level taxonomy.
   C. Maximum pronotal width to its maximum length ratio (WP/LP). The WP/LP value in two measured holotypes (or lectotypes) is with exception of males of *C. s. scabrosum* within the minimum and maximum intervals found in the pertinent populations and sexes. In the holotype of *C. aethiops* is the WP/WH value within the interval found in all compared species of both sexes. Overall the WP/LP values found in the measured taxa are quite non-specific in both species and sexes (Table 1c, Table 2), and in our opinion thus cannot be used as a criterion in species-level taxonomy.
   D. Maximum elytral length to its maximum width ratio (LE/WE). The WP/LP value in two measured holotypes (or lectotypes) is in both subspecies of *C. scabrosum* within the minimum and maximum intervals found in the pertinent populations and sexes. In both sexes of *C. i. hottentotum* the value is outside the interval. In the holotype of *C. aethiops* the value is within the interval found in both subspecies of *C. scabrosum*. Overall the WP/LP values found in the measured taxa can be regarded as variable, namely in *C. i. hottentotum*. In our opinion they cannot be used as a criterion in species-level taxonomy (Table 1d, Table 2).

Table 1a. Total length, intervals.

Taxon Holotype (HT), lectotype (LT)	**Total length** including mandibles in millimeters (TL). Interval of minimum and maximum value of TL measured in 10 specimens of the same sex is in parentheses. Yes (Y) – TL value of type is within interval. No (N) – TL value of type is outside of interval.	
C. scabrosum scabrosum Chaudoir, 1843 (HT ♂)	25.5 (23.1–26.2 ♂♂)	Y
C. scabrosum roeschkei Breuning, 1927 (HT ♂)	25.0 (22.0–28.5 ♂♂)	Y
C. imbricatum hottentotum Chaudoir, 1852 (♂ LT Deuve 1978)	21.0 (17.5–21.3 ♂♂)	Y
C. aethiops (Jeannel, 1940) (HT ♂)	21.5 (*C. i. hottentotum* ♂♂ 17.5–21.3 ♀♀ 19.2–23.0)	N

Table 1b. Pronotal width to head width ratio, intervals.

Taxon Holotype (HT), lectotype (LT)	**Maximum pronotal width to maximum head width** inc. eyes ratio (WP/WH). Interval of minimum and maximum value of WP/WH measured in 10 specimens of the same sex is in parentheses. (Y/Y) – value of type is within interval. (N/N) – value of type is outside of interval. (N/Y) – value of type is outside of interval in males but within interval in females.	
C. scabrosum scabrosum Chaudoir, 1843 (HT ♂)	1.50 (1.34–1.44 ♂♂) (1.35–1.48 ♀♀)	N/N
C. scabrosum roeschkei Breuning, 1927 (HT ♂)	1.50 (1.29–1.63 ♂♂) (1.41–1.65 ♀♀)	Y/Y
C. imbricatum hottentotum Chaudoir, 1852 (♂ LT Deuve 1978)	1.45 (1.33–1.50 ♂♂) (1.23–1.54 ♀♀)	Y/Y
C. aethiops (Jeannel, 1940) (HT ♂)	1.32 (*C. i. hottentotum*) (*C. s. scabrosum*) (*C. s. roeschkei*)	N/Y N/N Y/N

Table 1c. Pronotal width to length ratio, intervals.

Taxon Holotype (HT), lectotype (LT)	**Maximum pronotal width to maximum pronotal length ratio** (WP/LP). Interval of minimum and maximum value of WP/LP measured in 10 specimens of the same sex is in parentheses. (Y/Y) – value of type is within interval. (N/N) – value of type is outside of interval. (N/Y) – value of type is outside of interval in males but within interval in females.	
C. scabrosum scabrosum Chaudoir, 1843 (HT ♂)	1.65 (1.33–1.56 ♂♂) (1.52–1.67 ♀♀)	N/Y
C. scabrosum roeschkei Breuning, 1927 (HT ♂)	1.67 (1.38–1.77 ♂♂) (1.47–1.74 ♀♀)	Y/Y
C. imbricatum hottentotum Chaudoir, 1852 (♂ LT Deuve 1978)	1.74 (1.43–1.74 ♂♂) (1.55–1.84 ♀♀)	Y/Y
C. aethiops (Jeannel, 1940) (HT ♂)	1.55 (*C. i. hottentotum*) (*C. s. scabrosum*) (*C. s. roeschkei*)	Y/Y Y/Y Y/Y

Table 1d. Elytral length to width ratio, intervals.

Taxon Holotype (HT), lectotype (LT)	**Maximum elytral length to maximum elytral width ratio** (LE/WE). Interval of minimum and maximum value of LE/WE measured in 10 specimens of the same sex is in parentheses. (Y/Y) – value of type is within interval. (N/N) – value of type is outside of interval. (N/Y) – value of type is outside of interval in males but within interval in females.	
C. scabrosum scabrosum Chaudoir, 1843 (HT ♂)	1.44 (1.44–1.56 ♂♂) (1.38–1.53 ♀♀)	Y/Y
C. scabrosum roeschkei Breuning, 1927 (HT ♂)	1.52 (1.39–1.57 ♂♂) (1.33–1.59 ♀♀)	Y/Y
C. imbricatum hottentotum Chaudoir, 1852 (♂ LT Deuve 1978)	1.54 (1.33–1.50 ♂♂) (1.38–1.57 ♀♀)	N/Y
C. aethiops (Jeannel, 1940) (HT ♂)	1.39 (*C. i. hottentotum*) (*C. s. scabrosum*) (*C. s. roeschkei*)	Y/Y N/Y Y/Y

Table 2. Intervals of all measurements in each taxon (intervals), in TL and LE/WE for both sexes separately and total.

C. s. scabrosum	23.1–26.2	23.1–26.2	23.4–25.7	1.35–1.63	1.33–1.67	1.38–1.56	1.44–1.56	1.38–1.53
C. s. roeschkei	22.0–28.5	22.0–28.5	24.1–27.9	1.29–1.65	1.38–1.77	1.33–1.59	1.39–1.57	1.33–1.59
C. senegalense	23.0–30.0	23.0–29.3	24.9–30.0	1.22–1.62	1.30–1.73	1.45–1.56	1.45–1.55	1.45–1.56
C. strandi	25.2–30.3	25.2–29.0	26.4–30.3	1.32–1.44	1.46–1.62	1.44–1.64	1.50–1.64	1.44–1.64
C. i. imbricatum	17.0–22.0	17.0–20.4	18.2–22.0	1.33–1.43	1.41–1.68	1.26–1.57	1.39–1.53	1.26–1.57
C. i. hottentotum	17.5–23.0	17.5–21.3	19.2–23.0	1.33–1.54	1.43–1.84	1.33–1.57	1.33–1.50	1.38–1.57

The above data lead us to conclude that there are no convincing morphological differences between *C. scabrosum scabrosum* and *C. scabrosum roeschkei*. The only exception may possibly be the somewhat higher WP/LP ratio (Table 2) and lighter coppery coloration in most specimens of *C. s. roeschkei*. Since specimens of both taxa have never been found together, we assume that they belong to allopatric populations of one species that have yet to reach the state of full speciation. Therefore, we lower the status of *C. roeschkei* (sensu Bruchi 2013) to a subspecies of *C. scabrosum*. *Calosoma scabrosum roeschkei* occupies mainly the southern part of distribution of the species. The present data show the north – south distribution of both subspecies to have a virtually disjunct character (Map 1). But it is in our opinion important to realize that in no area have the described subspecies been found to occur together. It is therefore likely that the northern Sudan – Ethiopia borderland will continue to produce *C. s. roeschkei*. The describer (Breuning 1927: 186) of *Calosoma scabrosum roeschkei* wrote: ["This form (*roeschkei*) is due to its more robust head, less bulging eyes, wider, toward base more right-angled pronotum with more rounded hind angles, shallower basal pits, somewhat flatter, at shoulders broader and terminally more abruptly slanted elytra and dark to brownish bronze dorsal coloration with light brown, coppery-rimmed margins and foveae in primary intervals so

Map 1. Geographic distribution of the *Calosoma scabrosum* and *Calosoma strandi* species subgroups (sensu Häckel 2012). T – the type locality. Dark blue discs – *Calosoma scabrosum* s. str. Chaudoir, 1843. Light blue discs – *Calosoma scabrosum roeschkei* Breuning, 1927. Green discs – *Calosoma strandi* Breuning, 1934.

conspicuous that I originally intended to describe it as a separate species. However, some individuals of this form (*roeschkei*) are clearly transitional to the typical form (*scabrosum*), with coloration remaining as the only constant character. Differences (of separate populations) from the nominotypical form show step-like transitions, for which reason I presently regard *C. roeschkei* as a subspecies of *C. scabrosum*" (original in German)].

Jeannel (1940: 128) did not see Breuning's subspecies but treated it as a variety and remarked: ["Breuning's variety *roeschkei* rather appears to be another (separate) species closely related to *C. scabrosum*]"; he did not further comment on the taxon and placed specimens corresponding to Breuning's description among African populations of "*C. orientale*" (Jeannel 1940: 128). In this connection, Jeannel and subsequent authors such as Rougemont (1976: 247) and Vigna Taglianti and Bruschi (1986: 21) solved taxonomic uncertainties by incorrect determination of specimens from eastern

Africa as *C. squamigerum* Chaudoir, 1869 (Häckel 2012: 57.). The holotype of *C. squamigerum* is from Bengal (today either Bangladesh or West Bengal in India) and other specimens of the type series are from Coimbatore in the vicinity of Madras (today Tamilnadu State in southern India). The name *C. squamigerum* was therefore synonymized with *C. orientale* (Jeannel 1940: 128).

Jeannel nevertheless realized that African populations identified as *C. orientale* (=*squamigerum*) most likely belong to another species, coined for them a new taxon, *Ctenosta* (s. str.) *aethiops* Jeannel, 1940, and included in the distribution of this taxon also populations corresponding to Breuning's *C. s. roeschkei* ("Diré Daoua", Jeannel 1940: 128). The only exception was a population from Eritrea ("Tessenei" 1940: 129), which he continued regarding as *C. orientale*. In the description of *C. aethiops* Jeannel (1940: 127–128) wrote: ["if we regard *C. aethiops* with its gular and labial setae as belonging to the genus *Caminara*, we can see that in reality it is a transitional species combining characters of *Caminara* and *Ctenosta*, an important species attesting to its assignment to the genus *Ctenosta,* which differs by reduction of the said setae and the type of sculpture placing it near the *Castrida-Caminara* lineage. The male mesotibiae have the setal brush prolonged as in *Caminara* and similar to that present in *Ctenosta.* The ventral side of the fourth male protarsomere is smooth]".

Evident from Jeannel's text are the difficulties he had in placing the new species in his system and in defining the "genera". More recently some authors (Culot 1990, Bousquet et al. 2003, Bruschi 2013) regarded the genera as subgenera, but in our opinion Jeannel's criteria do not allow to distinguish them. For instance Bruschi in the key does not adhere to Jeannel's criteria (setae, elytral microsculpture) and originally separates *Caminara* from *Ctenosta* on the hind pronotal angles. In the key he (2013: 29) states: "13(14) always perceptible hind angles of pronotum – *Caminara/ Campalita*; 14(13) very small and pointed hind angles of pronotum, in some cases quite obliterated". In our opinion Jeannel's genera are not valid, which is supported also by their discord with results of DNA analyses. With only one exception, all the subgenera were synonymized with the genus *Calosoma* s. str. (Häckel 2012: 56, 2013: 12). Jeannel's difficulties in separating the "genera" *Ctenosta* and *Caminara* (according to us two close species groups of the genus *Calosoma*) reflect the confused composition of the type series of his *C. aethiops*. Without examination of Jeannel's holotype of *C. aethiops*, most subsequent authors regarded all African populations similar to *C. scabrosum*, with golden bronze coloration, as *C.* (*Ctenosta*) *aethiops* (Vigna Taglianti and Bruschi 1986: 21, Culot 1990: 9, Lorenz 2005: 68).

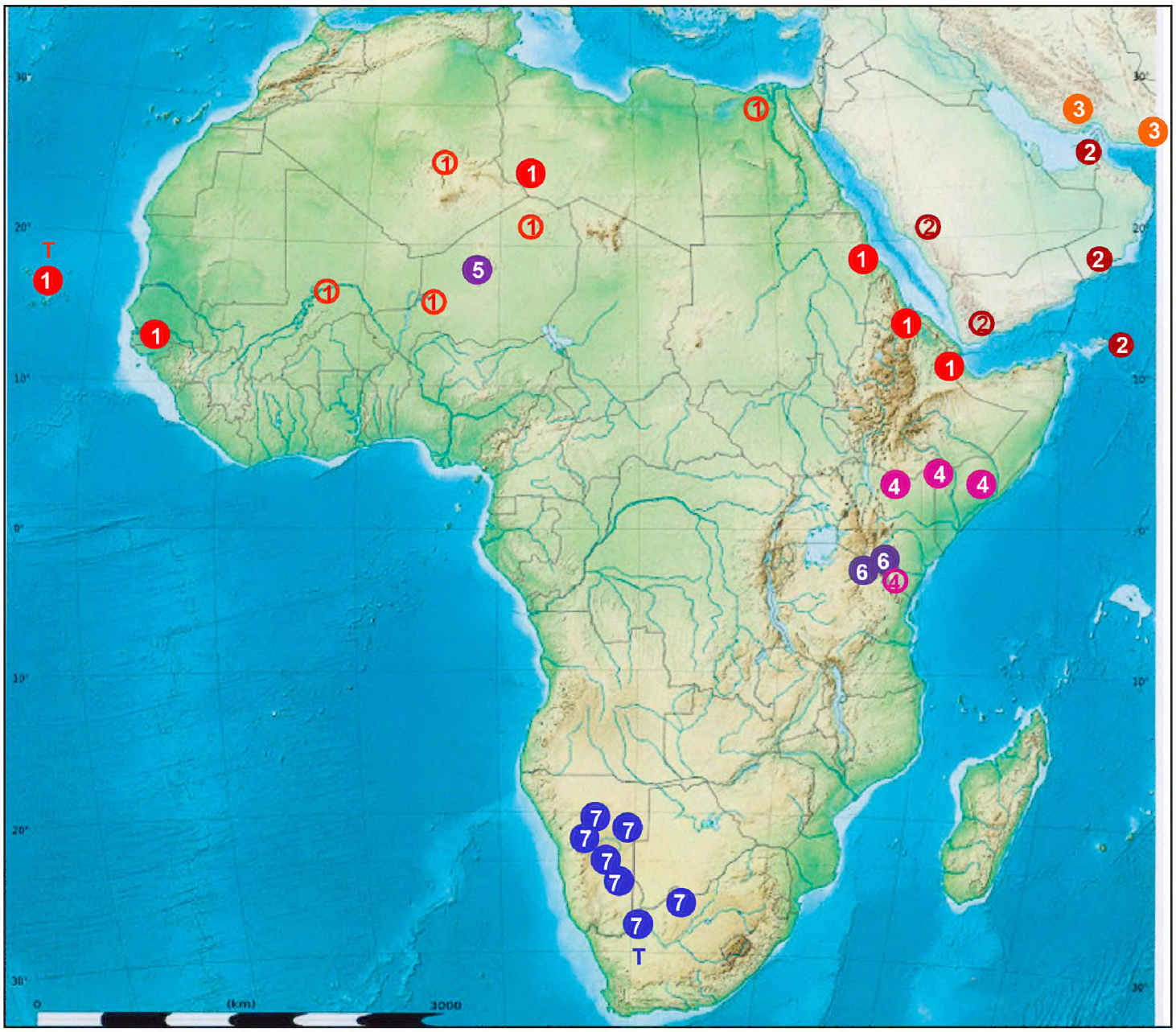
Only Bruschi, first on the internet and later in print (2013: Plate 17: Figs 8, 9), published photos of the holotypes of *C. scabrosum roeschkei* (Tanzania: Usambara) and *C. aethiops* (Niger: Azbin). The holotype of *C. s. roeschkei* (Usambara, see Map 1) clearly is a species belonging to the *C. senegalense* group, and we concur with Bruschi that in compliance with the priority principle the taxon must be ascribed to Breuning (the name *C. s. roeschkei* has priority over *C. aethiops*, if the two are the same species).

However, in our opinion the specimen from Azbin (Jeannel's holotype of *C. aethiops*) looks different and does not belong to the *C. senegalense* group (=Jeannel's genus

Ctenosta). Our comparisons of types and their aedeagi show that the holotype of *C. aethiops* corresponds in shape, size and sculpture of the elytra, shape of the legs, and termination of the aedeagus to *C. imbricatum hottentotum* Chaudoir, 1852. It belongs to another group (*C. maderae* group, *C. imbricatum* subgroup sensu Häckel, 2013: =Jeannel's genus *Caminara*), which partially overlaps the distribution of the *C. senegalense* group. Our conclusions are based chiefly on the different aedeagal morphology unequivocally shown by the photos (Plate 3, Figs 1, 2 versus Fig. 3). Futher documentation of morphological characters is not needed.

Calosoma imbricatum sensu lato is by a number of authors understood as a species with an extremely wide distribution reaching from Canary and Cape Verde Islands through the African Sahel belt, subsaharan Africa, Arabia, Iran and Pakistan to India and Bagladesh (Breuning 1927: 221–223, Jeannel 1940: 104–106, Mandl 1970: 61–63, see Map 2). The cited authors identify southern African populations of *C. imbricatum* as the subspecies *C. i. hottentotum*, whose holotype comes from the Cape province (Chaudoir 1852: 99). *Calosoma imbricatum hottentotum* is usually regarded as cofined to southern Africa, and Mandl (1970: 61, 63) even named another subspecies, *C. i. linnavourii*, for populations from eastern Africa (northern Kenya, Somalia), which is a transitional form differing from the northern (Sahel-Arabian) nominotypical form (*C. i. imbricatum*) by wider pronotum. Populations from southern Kenya and northern Tanzania with more lighter coppery coloration approaching rather the southern African populations (*C. i. hottentotum*). Jeannel (1940: 105) is the only author who regarded also the Kenya population as *C. i. hottentotum*. Mandl (1970: 63) commented these occurrences as "Wahrnscheinlich gehören die folgende Orte zu dieser Subspecies [*C. i. linnavourii*]: Kenya Sultan Hamid zwischen Voi und Nairobi, die Jeannel für *hottentottum* angibt", and Bruschi (2013) countered: „It seems that, contrary to the opinions of Mandl (1970: 61) that attributed this citation to his *C imbricatum linnavourii*, Jeannel is right since in south western Kenya *C imbricatum hottentotum* is really present". In our opinion it is evident that the northern limit of *C. i. hottentotum* is vague and hosts a number of forms transitional to the nominotypical *C. i. imbricatum*. It is therefore possible that Jeannel's type of *C. aethiops* from Azbin (today northern Niger) belongs to one of the transitional populations and the locality is in fact correct (see Map 2). In our opinion Jeannel's type series of *C. aethiops* contains the holotype that we regard as *Calosoma imbricatum* (most likely the subspecies *hottentotum*) and specimens from other populations belonging to some of the subspecies of *C. scabrosum*, mostly to *C. s. roeschkei*.

Comparison of the types of *C. s. scabrosum* and *C. s. roeschkei* in our opinion also confirms the original Breuning's idea of one species with two terminal forms and a number of transitional forms between them (Plate 1: Figs 1–2). Another taxonomical inaccuracy was caused by Häckel et al. (2005: 2), who believed that populations newly discovered on the Arabian peninsula (Oman, Yemen, see Map 1) represent a different species (*C. jakli*, Plate 2. Fig. 2). Eventually, after comparison with the type of *C. s. scabrosum* it became clear that the Arabian specimens agree with the type (Häckel et al. 2010: 11), and today they are included in the distribution of the nominotypical subspecies *C. scabrosum* s. str. (Müller 1977, Häckel 2012: 57).



Map 2. Geographic distribution of the *Calosoma imbricatum* species subgroup (sensu Häckel 2013) compared to Mandl's data (1970) and *C. imbricatum hottentotum* Chaudoir, 1852. T – the type locality, ● (full disc) – recent records, ○ (empty disc) – Mandl's data **1–4** *Calosoma imbricatum* s. str. Klug, 1832 **5–7** *Calosoma imbricatum hottentotum* Chaudoir, 1852 **1** *C. imbricatum* s. str. (sensu Mandl 1970) **2** *C. imbricatum arabicum* (Motschulsky, 1865) sensu Mandl 1970 **3** *C. imbricatum löffleri* Mandl, 1953 sensu Mandl 1970 **4** *C. imbricatum linnavourii* Mandl, 1970 sensu Mandl 1970 **5** *C. imbricatum hottentotum* (holotype of *Ctenosta aethiops* Jeannel, 1940) **6** *C. imbricatum hottentotum* (*C. imbricatum linnavourii* sensu Mandl 1970) **7** *C. imbricatum hottentotum.* sensu Mandl 1970.

Below we present morphometric tables comparing populations of *C. s. roeschkei* (hitherto labeled as *C. aethiops*) with specimens of *C. s. scabrosum* the Horn of Africa (Djibouti) and the Arabian peninsula (Oman, Yemen). The tables also compare the noted populations of *C. scabrosum* with specimens of *C. i. hottentotum* from southern and eastern Africa and *C. i. imbricatum* from Afrotropical Region. In this connection we consider it important that no known locality has produced sympatrically living *C. s. scabrosum* and *C. s. roeschkei* (see Map 1). However, at at least one locality (Kenya: North-Eastern Province, El Wak, see Map 1) has produced *C. scabrosum* (ssp. *roeschkei*) together with *C. imbricatum* (ssp. *hottentotum*) and another species of the *C. senegalense* group (*C. strandi* Breuning).

Our conclusion therefore is that Breuning's (1928: 185) original idea is valid, and consequently we demote *C. roeschkei* sensu Bruschi (2013: 129) to a subspecies of *C. scabrosum.*

The subgeneric placement of *C. imbricatum*, *C.* in the subgenus *Calosoma* follows the recently proposed classification supported by results of DNA analyses (Su et al. 2005, Häckel 2012, 2013).

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